An Options-Based Approach to Capabilities Based Planning

Executive Summary

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The goal is a streamlined and collaborative, yet competitive, process that produces fully integrated joint warfighting capabilities.

"Initiation of a Joint Capabilities Process," Secretary of Defense Rumsfeld. 31 Oct Memo.

Research Problems

This research will provide an options-based methodology to support Capabilities Based Planning (CBP). To accomplish this, we must solove a series of interrelated problems:

- Establish the comparability between DoD activities and capital market activities in order to:
    - Provide a rationale for applying powerful corporate financial models and rigor to DoD/CBP decision making;
    - Use Knowledge Valuation Analysis (KVA) to unlock new sources of data to make options-based analysis for DoD/CBP decision processes more practical and rigorous.
- Demonstrate the effectiveness of real options analysis within the CBP and other DoD frameworks as a means to:
    - Build analytical descriptions of the options residing in current and proposed knowledge assets (people, technology, processes, intellectual property);
    - Optimize the use of current knowledge assets.
- Identify and use software that incorporates the real options analysis models needed to perform CBP in a practical and rigorous way.

Assumptions-Propositions

I. Military and Capital Markets are Similar

The DoD participates as the major player in an external market, the "global battlespace market." In addition, it constitutes an internal market (we call it the *k-market*, i.e. knowledge market). Both the *global battlespace market* and the *DoD k-market* bear important similarities to the global capital markets in the corporate arena. All these external and internal markets are:

A) Populated by various entities competing and cooperating for scarce resources and "market share;"

B) Characterized by complexity, flux, change, turbulence, randomness, risk, uncertainty;

C) Described by means of observable, historical empirical data on activities and transactions that are used to reconstruct the past and predict future risks and rewards;

D) Repleat with knowledge gaps, surprises, data smog, information fog and so forth, (even though the capital market theory purports to have "efficient markets" in which all players know all things about each other at all times);

E) A hotbed of games and strategies with the goals of minimizing or mitigating risk and maximizing or optimizing reward (e.g., positive outcomes such as military mission success, increased revenues, gain of market share, etc.).

At the *global battlespace market* level, the six externally directed primary combat processes described in the IJWA publication, *A Concise Theory of Combat*, (Edmund L. DuBois, Wayne P. Hughes, Jr., Lawrence J. Low. NPS-IJWA-97-001. 1998. p. 61) are comparable to the corporate arena in describing desired market outcomes such as:

- Constructing high barriers to entry (Demoralization);
- Taking out competitors through "first mover advantage" or "hostile takeovers" (Destruction);
- Or aggressive legal tactics regarding intellectual property or aggressive marketing/advertising tactics regarding product (Suppression).

At the *DoD k-market* level, the DoD Command are "investors" in portfolios of assets (capabilities) for use in DoD core processes and infrastructure at both the tip and tail of the spear.

Although military and corporate market terms and definitions are not identical and the military context represents the ultimate in high-stakes "investment" activity, we will demonstrate that the differences between the DoD and corporations are those of degree rather than kind. Thus, we feel that financial ratios (as indicators of organizational performance) and cutting edge financial predictive tools can be effectively applied to DoD "investing" activities in the internal *k-market* as well as the external *global battlespace market*.

See Appendix A for diagrams of these concepts.

II. Real Options Analysis will Assist DoD/CBP Decision Makers

Financial options provide *investors in the capital markets* with more alternatives and more risk/reward profiles from which to choose. In much the same way, real options provide *investors in the information technology, human capital, processes, and projects of the organization* (here, military capabilities) with more alternatives and more risk/reward profiles from which to choose. By systematically incorporating real options analysis in operations and planning, DoD decision makers will have a better understanding of the risk-rewards profiles of the decision options embedded in its capabilities portfolios.

There are two main categories of real options available to the DoD. All standard real option alternatives will fit within these two categories:

A) *Transaction-Related.* Examples:

1) The *option to expand, contract, or switch use* of combat elements, for instance in the area of forcing decisions for capabilities based planning;
2) The *option to shut down and restart* operations at the tip of the spear;
3) Eventually, the *battlespace options available to combatant commanders.*

B) *Acquisition-Related.* Examples:

1) The *option to invest* in some IT (or other military) projects rather than others, in order to achieve and maintain optimal Network Centric Operations or other objectives;
2) The *option to shut down and restart* operations at the tail of the spear (for instance, downsizing the tail and recapitalization in investments at the tip of the spear);
3) The *option to withdraw during staged construction* of infrastructure or warfighting projects;
4) The *option to defer investment* in infrastructure or warfighting capabilities;
5) The *option to abandon for salvage value* when infrastructure or warfighting capabilities no longer contribute the required option value to overall DoD strategies.

III. Knowledge Valuation Analysis (KVA) Provides a New Source of Raw Data

Knowledge Valuation Analysis (KVA) provides a new source of raw data for use in capabilities investment decisions and capabilities portfolio management. This data:

A) Provides a common unit of output for all processes, never available before;

B) Describes, in common units, the performance of the operational infrastructure, including information technology (e.g., ForceNET). Since it is mined at the operational/process level, it is the most directly representative of the ongoing performance of the organization at the sub-organizational level;

C) Can be collected and presented at as detailed or aggregated a level as decision makers require;

D) Allows us to develop a numerator for valuation measures, instead of having to rely on estimates built from cost, “market comparable,” or “process of elimination” approaches.

E) Allows us to provide traditional external-market oriented corporate finance with new concepts, such as the internal “knowledge” market of the firm and the Knowledge Asset Pricing Model, that offer fresh insights and solve some common estimation problems.

F) Will allow the DoD to populate the traditional real options analysis model with valid data to enable reasonable quantitative assessments of risk (volatility) and uncertainty (probability), given the attributes of the DoD “markets.”

IV. *Crystal Ball* Decision Support Software will Make Real Options Analysis and Other Sophisticated Financial Analyses Practical for DoD Decision Makers

We have identified *Crystal Ball* decision support software (by Decisioneering Inc.) as “best in breed” to support real options analysis for CBP and other projects. This software has greatly simplified the assessment of uncertainty and risk using traditional Monte Carlo and other simulation models, as well as the use of real options analysis. Although *Crystal Ball* currently

does not collect or analyze KVA data, KVA data can be used in the software the same way other financial data is used.

What are Real Options?

An option is the right, *without the associated symmetric obligation*, to buy or sell a particular asset by paying a predetermined price (the "exercise" or "strike" price for financial and real options, or "implementation cost" for real options) on or before a specified expiration (maturity) date. If an option can only be exercised at maturity, it is called a European option; if it can be exercised any time before maturity, it is called an American option.

The value of the option is based on the expected present value of the [benefits less cost] related to an *underlying asset,* adjusted for the uncertainty (probabilities) and risk (volatility) associated with the model inputs over time. The underlying asset can be a financial asset (i.e., shares of common stock, stock indexes, bonds, currencies, etc.) or *a real asset in the form of specific real property such as a gold mine or oil well, or in the form of a capital project.*

Real options are named according to the kinds of choices (options) available to management through the life of the option: Abandonment, expansion, "choosing," deferral, switching, growth, and many other simple and compound options.

While many decision makers are familiar with the general notion of options thinking, *real options analysis* draws on the Nobel prize winning work of Scholes and Merton (1994) to provide rigorous structure for uncovering and valuing/evaluating the options resident in proposed activities and transactions involving non-financial assets.

What is the Real Options Analysis Process?

A highly simplified overview of the process, as laid out by Decisioneering's *Crystal Ball* Real Options Analysis software, is as follows. The *Crystal Ball* software can perform Steps 2, 3, 5, and 6 within a few seconds and produces elegant, informative reports for each. The deep analysis, however, must be done by the practitioner/analyst. (*Real Options Analysis*, Johnathan Mun, PhD. Wiley. 2002. p.322)

1. Develop a list of projects or strategies to evaluate;
2. Do a "base case" NPV analysis using time series forecasting to generate static discounted cash flow (DCF) models for each;
3. Use DCF results as initial inputs into Monte Carlo simulation, where volatility and correlations are imputed to the inputs;
4. Frame each problem in terms of a real option structure and select relevant options to analyze further;
5. Calculate options results using binomial lattices and closed-form partial differential equations (Black-Scholes models) with simulation;
6. If appropriate, perform portfolio resource optimization and allocation analysis.

What are Some of the Current Limitations of Real Options Analysis?

Some of the limitations still being grappled with by the real options academic and practitioner communities are:

A. The “black box problem,” i.e. the complexity and obscurity of the mathematical formulas used. Example: Black-Scholes option pricing model for a call option is:

$$Call = S_t\Phi(d_1) - Xe^{-rf(T)}\Phi(d_2)$$

$$\text{Where } d_1 = \frac{\ln(S_0/X) + (rf + .5\sigma^2)(T)}{\sigma\sqrt{T}}$$

$$\text{and } d_2 = d_1 - \sigma\sqrt{T}$$

B. Difficulty in developing an appropriate estimation of the value and riskiness of the underlying assets;

C. An inability to replicate the underlying assets in a market portfolio, without having to go through theoretical contortions;

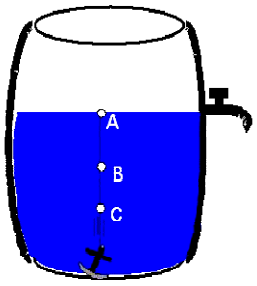
D. A lack of structure and repeatability of the problem;

E. And an inability to check results against reality.

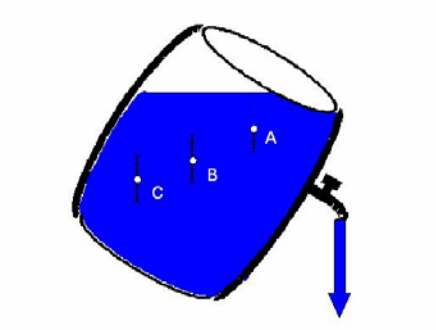
KVA will supply the data sets to overcome real options analysis limitations B - E at their most fundamental level. Training in the approach, using KVA data and *Crystal Ball* software, should reduce or eliminate “complexity of use” issues.

The CBP Force Mix Challenge

> How the DoD sizes and configures its forces will in large part determine the future success of its strategies to protect our nation’s security. . . At heart, these insightful analyses have all sought to answer the riddle-like problem eloquently expressed by Army Chief of Staff General Schoomaker in his well-known “spigot” analogy. The total army force, asserts General Schoomaker, “is like a barrel with the spigot too high.”



> Note that assets (in General Schoomaker’s case the assets are human, in our model the assets can be human and technological) A, B, and C are held in place by an organizational structure-culture anchor. This anchor will not permit horizontal movement of the capabilities to enable them to align with valued mission goals. . . .



> Metaphorically, we can achieve the goal of a full-flowing spigot of high-capability personnel without increasing the overall "volume" of such human assets by "tipping the barrel." With this metaphorical alternative, we virtually have released our assets from their anchoring mechanisms and allowed them to meet the demands of given missions. This reduction in the organization's structural-cultural inertia allows talent to use more self-organizing principles to locate missions that require given capabilities that may be bolstered with a bit more training or refreshing experience. Thusly, the capabilities can surge to meet given mission demands based on individual initiative rather than purely from traditional command and control structures.[1]
>
> [1:] Housel, Bell, Nelson. Sept. 2004;
> Barrel concept taken from draft copy, "Structuring a Flexible Force to Meet Strategic Demand."
> Office of Force Transformation, June 2004.

The question is, How do we tip the barrel?

The suggestion has been made to do a full inventory of all human assets and their capabilities and then develop decision-making algorithms and revise training and education programs to embed further "options" into the force mix.

We suggest that the analysis should begin at an even more fundamental level. At this level, we can use KVA data and *Crystal Ball* simulation and real options analytic tools to identify and quantify the available options for tipping the barrel ***before*** decision-making algorithms have been developed or training (or any) decisions have been made.

A Real Options Analysis Case Example for CBP Force Mix

We are in the process of completing KVA on a case study conducted by Booz Allen Hamilton for the Office of the Secretary of Defense (OSD) Office of Force Transformation (OFT). The subject of the study was the evolution of the Mission Support Center used by the Special Operations Forces (SOF) within the Naval Special Warfare Group One (NSWG1). The baseline case was the people, processes and technologies that existed in the MSC during Operation Enduring Freedom (OEF). The treatment case was the people, processes and technologies that existed in the MSC during Operation Iraqi Freedom (OIF).

Our goal has been to offer new performance data for the processes described in this case study as an example of the use of KVA. Currently, we have set up the model and populated it with *fabricated data* while we gather actual data for further use. For this presentation, we will use the

fabricated data so that we can demonstrate KVA's usefulness within a real options analysis framework.

Steps to Completing Hypothetical RO Analysis for SOF Mission Support Center Case

Command has reviewed and analyzed the results of the KV analysis performed on the SOF Mission Support Center for Operation Iraqi Freedom. The following are some of the conclusions they have drawn from the data:

1. If tasks are clustered differently, it will be possible to use only 3 analysts instead of 5 to accomplish the same outputs. Therefore, Processes 1, 2, 9, and 10 will be assigned to a single analyst. And Processes 3-7 will be assigned to 2 additional analysts.

2. The requirements of projected combat potential indicate that Joint Forces will need an additional 30 Mission Support Centers within the next 3 years for use in forward deployment and also based in the U.S.

3. KVA forecasts will be performed and then used in real options analysis to determine the value of various forcing options available to the Joint Command for staffing out these MSCs during the projected time.

For the purpose of forecasts, the following is assumed:

1. The forecast period will be a full year.

2. The number of missions run by a single MSC during a year will remain equal for each of 3 future years. This number will be 14, the number run by the original MSC during the original sample period (41.67% of a year). Since there will be more MSCs in operation in the future, we chose not to increase the number of missions supported per MSC.

3. Each MSC will have the same configuration as the original one, per revision above.

4. The original MSC analyst 3 selected to staff Processes 1,2,9, and 10 going forward has 5.5 years of experience. It takes approximately 3.6 total years for a single analyst to learn Processes 1, 2, 9, 10. So we should look for analysts with 4 years of related experience to fill future slots.

5. The original 2 MSC analysts selected to staff Processes 3-7 going forward have an average of 11.5 years of experience. It takes approximately 22 total years for a single analyst to learn Processes 3-7, if none of the process knowledge overlaps. However, we assume that Processes 3-7 do overlap quite a bit. We assume that knowledge overlaps cut total learning time in half, to 11 years. We should look for analysts with 8 years of related experience to fill future slots.

6. We will assume that the role of IT in each process will increase by 5% per year going forward.

There will be 3 scenarios considered for staffing the new MSCs. Each has been forecasted by year in Tables in Appendix D.

Scenario 1 – Re-train U.S. Joint Forces Reserves
We assume that one year of prior related experience is equivalent to .5 year of experience in new position.

Scenario 2 – Re-train NATO Allies with related experience. The Commander will still be U.S. Joint Forces.

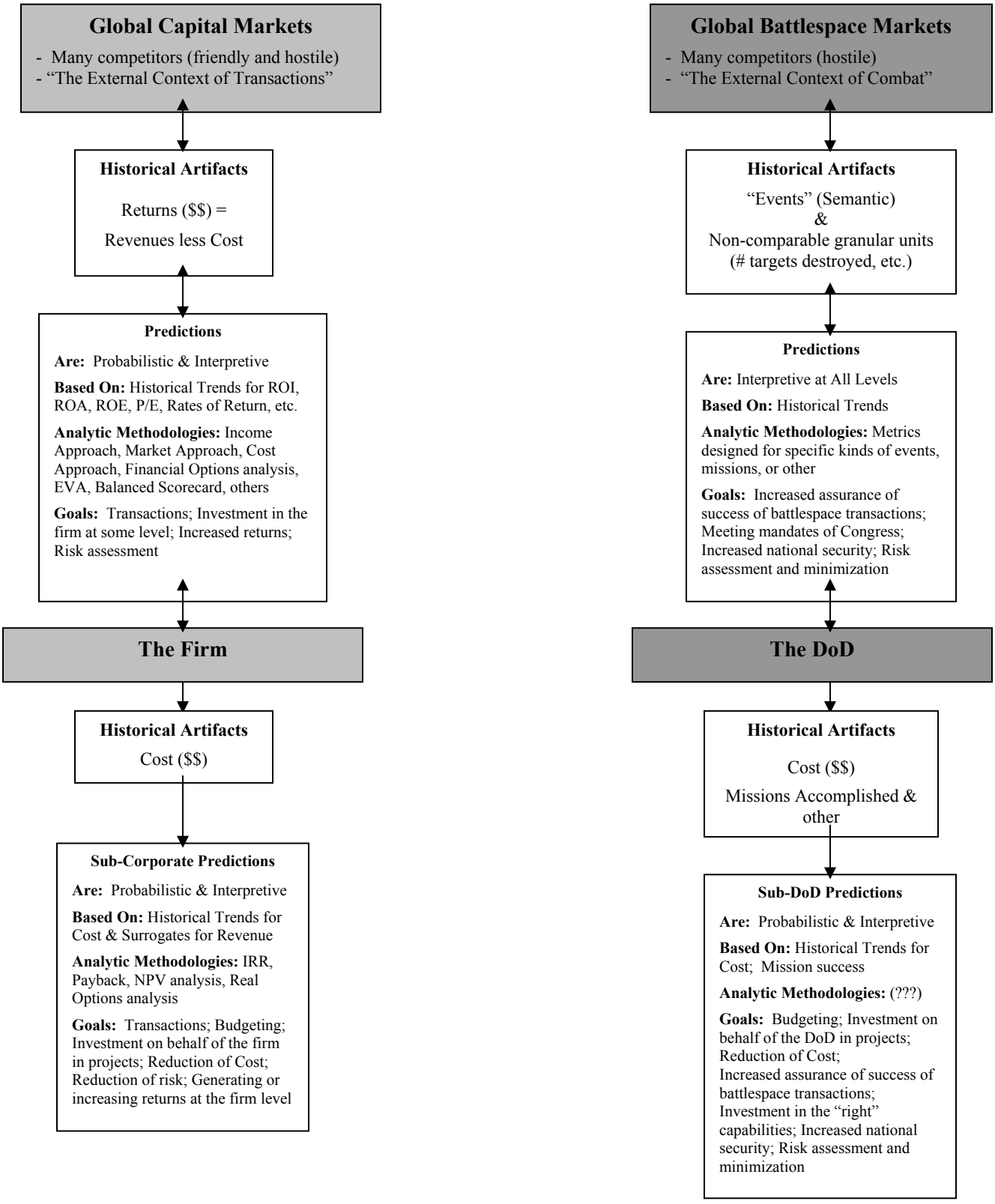
1. We assume that one year of prior related experience is equivalent to .4 year of experience in new position, due to differing experiences in IT platforms (etc.) for non-US personnel.

2. Due to use of non-U.S. personnel, we will delete factor for reduction of learning time through higher education.

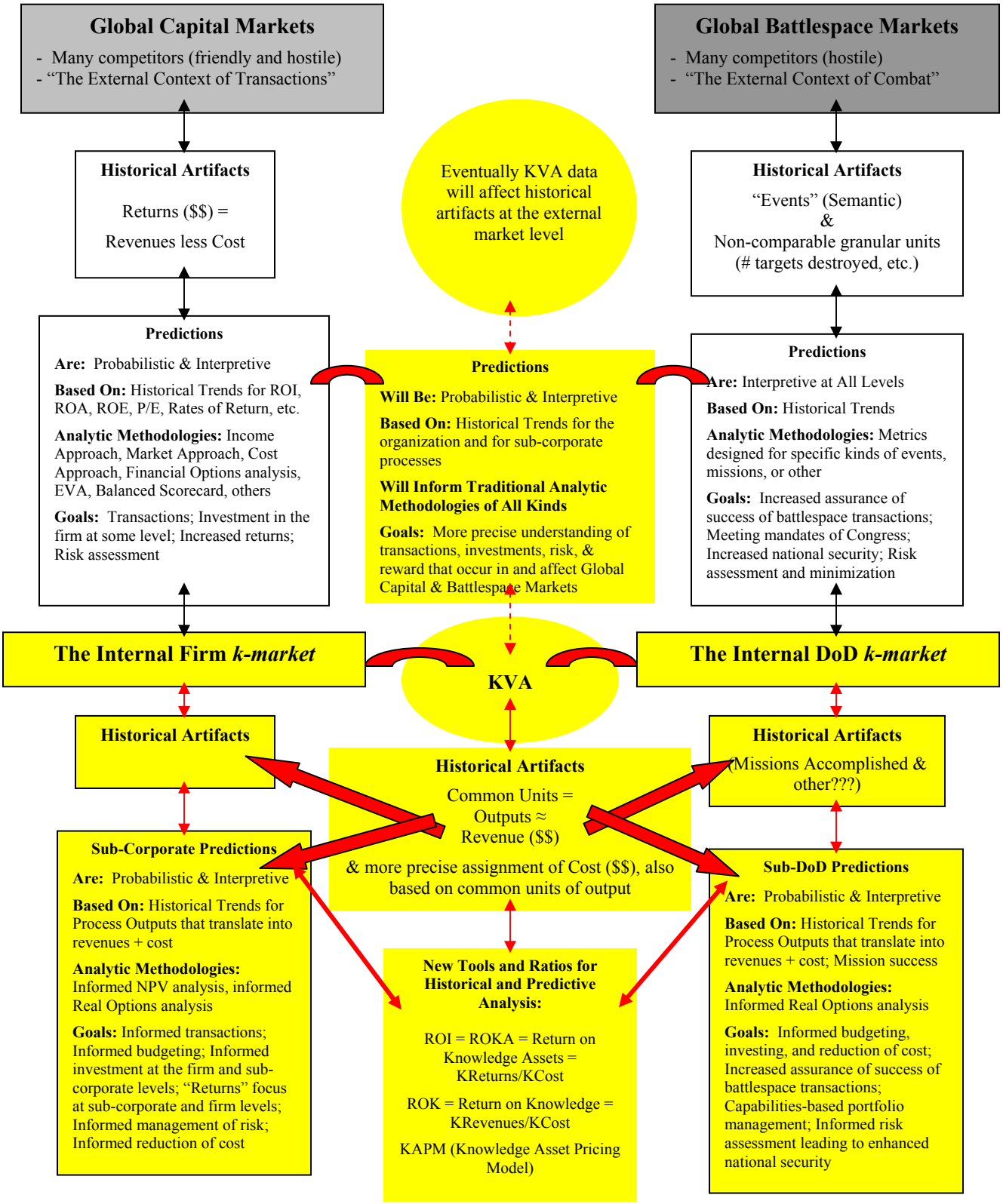
Scenario 3 – Outsourcing to U.S. civilians with strongly similar experience.
1. We assume that one year of prior related experience is equivalent to .9 year of experience in new position.

2. We assume that the DoD has been able to obtain a 10% discount on "going rate" salaries from outsourcing vendor.

APPENDIX A.1


Global Capital Markets
- Many competitors (friendly and hostile)
- "The External Context of Transactions"
Historical Artifacts
Returns ($$) =
Revenues less Cost
Predictions
Are: Probabilistic & Interpretive
Based On: Historical Trends for ROI, ROA, ROE, P/E, Rates of Return, etc.
Analytic Methodologies: Income Approach, Market Approach, Cost Approach, Financial Options analysis, EVA, Balanced Scorecard, others
Goals: Transactions; Investment in the firm at some level; Increased returns; Risk assessment
The Firm
Historical Artifacts
Cost ($$)
Sub-Corporate Predictions
Are: Probabilistic & Interpretive
Based On: Historical Trends for Cost & Surrogates for Revenue
Analytic Methodologies: IRR, Payback, NPV analysis, Real Options analysis
Goals: Transactions; Budgeting; Investment on behalf of the firm in projects; Reduction of Cost; Reduction of risk; Generating or increasing returns at the firm level
Global Battlespace Markets
- Many competitors (hostile)
- "The External Context of Combat"
Historical Artifacts
"Events" (Semantic)
&
Non-comparable granular units
(# targets destroyed, etc.)
Predictions
Are: Interpretive at All Levels
Based On: Historical Trends
Analytic Methodologies: Metrics designed for specific kinds of events, missions, or other
Goals: Increased assurance of success of battlespace transactions; Meeting mandates of Congress; Increased national security; Risk assessment and minimization
The DoD
Historical Artifacts
Cost ($$)
Missions Accomplished & other
Sub-DoD Predictions
Are: Probabilistic & Interpretive
Based On: Historical Trends for Cost; Mission success
Analytic Methodologies: (???)
Goals: Budgeting; Investment on behalf of the DoD in projects; Reduction of Cost;
Increased assurance of success of battlespace transactions;
Investment in the "right" capabilities; Increased national security; Risk assessment and minimization

APPENDIX A.2


Global Capital Markets
- Many competitors (friendly and hostile)
- "The External Context of Transactions"
Global Battlespace Markets
- Many competitors (hostile)
- "The External Context of Combat"
Historical Artifacts
Returns ($$) =
Revenues less Cost
Eventually KVA data will affect historical artifacts at the external market level
Historical Artifacts
"Events" (Semantic)
&
Non-comparable granular units
(# targets destroyed, etc.)
Predictions
Are: Probabilistic & Interpretive
Based On: Historical Trends for ROI, ROA, ROE, P/E, Rates of Return, etc.
Analytic Methodologies: Income Approach, Market Approach, Cost Approach, Financial Options analysis, EVA, Balanced Scorecard, others
Goals: Transactions; Investment in the firm at some level; Increased returns; Risk assessment
Predictions
Will Be: Probabilistic & Interpretive
Based On: Historical Trends for the organization and for sub-corporate processes
Will Inform Traditional Analytic Methodologies of All Kinds
Goals: More precise understanding of transactions, investments, risk, & reward that occur in and affect Global Capital & Battlespace Markets
Predictions
Are: Interpretive at All Levels
Based On: Historical Trends
Analytic Methodologies: Metrics designed for specific kinds of events, missions, or other
Goals: Increased assurance of success of battlespace transactions; Meeting mandates of Congress; Increased national security; Risk assessment and minimization
The Internal Firm k-market
KVA
The Internal DoD k-market
Historical Artifacts
Historical Artifacts
Common Units = Outputs ≈ Revenue ($$)
& more precise assignment of Cost ($$), also based on common units of output
Historical Artifacts
(Missions Accomplished & other???)
Sub-Corporate Predictions
Are: Probabilistic & Interpretive
Based On: Historical Trends for Process Outputs that translate into revenues + cost
Analytic Methodologies: Informed NPV analysis, informed Real Options analysis
Goals: Informed transactions; Informed budgeting; Informed investment at the firm and sub-corporate levels; "Returns" focus at sub-corporate and firm levels; Informed management of risk; Informed reduction of cost
New Tools and Ratios for Historical and Predictive Analysis:
ROI = ROKA = Return on Knowledge Assets = KReturns/KCost
ROK = Return on Knowledge = KRevenues/KCost
KAPM (Knowledge Asset Pricing Model)
Sub-DoD Predictions
Are: Probabilistic & Interpretive
Based On: Historical Trends for Process Outputs that translate into revenues + cost; Mission success
Analytic Methodologies: Informed Real Options analysis
Goals: Informed budgeting, investing, and reduction of cost; Increased assurance of success of battlespace transactions; Capabilities-based portfolio management; Informed risk assessment leading to enhanced national security